

87



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/964,709	09/28/2001	Vassoudevane Lebonheur	219.40446X00	1852

20457 7590 08/28/2002

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EXAMINER

CHAMBLISS, ALONZO

ART UNIT	PAPER NUMBER
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2827

DATE MAILED: 08/28/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/964,709

Applicant(s)

LEBONHEUR ET AL.

Examiner

Alonzo Chambliss

Art Unit

2827

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 06 November 2001.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-29 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 28 and 29 is/are allowed.
- 6) ☒ Claim(s) 1-6, 8-18, 20-24, and 27 is/are rejected.
- 7) ☒ Claim(s) 7, 19 and 25 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.,
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

Art Unit: 2827

DETAILED ACTION

1. Formal drawing filed on 11/06/01 have been approved by the examiner and made of record in Paper No. 2.

Specification

2. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed. The following title is suggested: " IMPROVING THERMAL PERFORMANCE IN FLIP CHIP/INTEGRAL HEAT SPREADER PACKAGES USING LOW MODULUS THERMAL INTERFACE MATERIAL ".

Claim Objections

3. Claims 10 and 11 are objected to because of the following informalities: because " 1-20 W/mk " and " 1-20 W/mK " has been typed incorrect. Respectively, it is suggested applicant change them to -- 1-20 W/m²K. Appropriate correction is required.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Art Unit: 2827

5. Claim 6, 8, 18, and 26 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

6. In claims 6, 18, and 26, the phrase " the modulus of elasticity of the thermal interface material is greater than 5kPA " is indefinite, since " greater than 5kPA " is a double inclusion which has already been included in the range 1-500kPA in independent claim 1.

7. In claim 8, the phrase " lightly cross linked polymer gel " is vague and indefinite since it is not clear what is meant by " lightly cross linked ".

Claim Rejections - 35 USC § 102

8. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in-

(1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or

(2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

9. Claims 1-3 and 6, insofar as definite, are rejected under 35 U.S.C. 102(e) as being clearly anticipated by Chen et al. (U.S. 6,403,882).

With respect to Claim 1, Chen teaches a semiconductor die 20 and a heat spreader 50, wherein a thermal interface material 45 (i.e. adhesive) between the

Art Unit: 2827

semiconductor die 20 and the heat spreader 50. The thermal interface material 45 has a modulus of elasticity in the range of 1-500Kkpa, the thermal interface material has modulus of elasticity of less than 1000psi (i.e. 50psi = 344.74kPa) see col.2 lines 42-55 and col. 3 lines 46-52. Giving the teachings of the above product, claim 1 is clearly anticipated by Chen.

With respect to Claim 2, Chen teaches a substrate 10 (i.e. a chip carrier for supporting a chip) on which the semiconductor die 20 and heat spreader 50 are mounted (see Fig. 3). Giving the teachings of the above product, claim 2 is clearly anticipated by Chen.

With respect to Claim 3, Chen teaches a substrate 10, wherein the semiconductor die 20 is a flip chip mounted (i.e. chip covered with conductive bump on its face that forms a face down solder connection or controlled collapse chip connection (C4)) on the substrate 10 (see Figs. 1-3). Giving the teachings of the above product, claim 3 is clearly anticipated by Chen.

With respect to Claim 6, Chen teaches the modulus of elasticity of the thermal interface material 45 that is greater than 5kPA, since the thermal interface material 45 is less than 1000psi (i.e. 50psi = 344.74kPa) see col.2 lines 42-55. Giving the teachings of the above product, claim 6 is clearly anticipated by Chen.

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

Art Unit: 2827

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

11. Claims 4 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (U.S. 6,403,882) and Seyyedy (U.S. 6,221,753) as applied to claim 1 above, and further in view of Vogel et al. (U.S. 6,317,326).

With respect to Claim 4, Chen discloses a semiconductor die 20 that is memory die (i.e. memory chip). Chen fails to explicitly disclose a semiconductor die that is a central processing unit (CPU). However, one skilled in the art would readily recognize substituting a CPU chip (i.e. CPU die) for a memory chip as evidence by Seyyedy (see col. 3 lines 13-18 and col. 4 lines 42 and 43).

With respect to Claim 5, Chen fail to disclose the heat spreader comprising a lid in heat conducting relation with the semiconductor die via the thermal interface material and wherein a heat sink is provided in heat conducting relation with the lid. However, Vogel discloses a heat spreader (i.e. lid which is serves a heat spreader by transferring

Art Unit: 2827

heat away from the die) comprising a lid 210 in heat conducting relation with the semiconductor die 206 via the thermal interface material 214 made of silicone and wherein a heat sink 216 is provided in heat conducting relation with the lid 210 (see col. 3 lines 66, 67 and col. 4 lines 1-6; Figs. 2A and 2B). Chen and Vogel have substantially the same environment of a flip chip connection between a chip and a substrate, wherein the back surface of the chip is bonded to a heat spreader by thermally conductive silicone adhesive. Therefore, it would have been obvious to incorporate the heat spreader comprising the lid connected to a heat sink with the product of Chen, since the combination of the heat spreader and the heat sink would increase heat dissipation of an integrated circuit device while retaining mechanical strength of the integrated circuit device as taught by Vogel.

12. Claims 8-18, 20, 21, 23, 24, 26, and 27 insofar as definite, are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (U.S. 6,403,882) and Seyyed (U.S. 6,221,753) as applied to claim 1 above, and further in view of Schoenstein et al. (U.S. 6,162,663).

Chen fails to disclose the following elements: a thermal interface material that is cured, lightly cross linked polymer gel filled with ceramic, a thermal interface material having a bulk thermal conductivity of 1-20 W/mK, a thermal interface material that is a gel which has a thickness between the semiconductor die and the heat spreader in the range of .001 - .010 inches, and curing a gel to form a thermal interface material which has a modulus of elasticity in the range of 1-500 kPa.

With respect to claims 8 and 9, Schoenstein discloses a thermal interface material 23 that is cured, cross linked polymer gel (i.e. silicone gel) filled with ceramic (i.e. aluminum oxide) (see col. 5 lines 24-45, col. 6 lines 12-23 and 54-65, and col. 8 lines col. 8 lines 44-50). The silicone gel is cross-linked after cured by using an UV light or high-energy radiation. Schoenstein does not explicitly disclose that the polymer gel is lightly cross-linked. However, the examiner interprets lightly cross linked as a gel that is mixed with several materials where one of the material parts per weight is lightly introduced into the final composition of the gel. Chen and Schoenstein both disclose substantially the same environment of a heat spreader attached to a die, wherein the die and the heat spreader are attached to substrate (i.e. circuit board). Therefore, it would have been obvious to substitute the filled silicone gel thermal interface material for the thermal interface material taught by Chen, since the filled silicone gel thermal interface material minimizes mechanical stress on both the die and the substrate and at the same time transfer heat away from the die as taught by Schoenstein.

With respect to Claims 10, 11, and 16, Schoenstein discloses a thermal interface material 23 having a bulk thermal conductivity of $1.08 \text{ w/m}^{\circ}\text{K}$ (i.e. between $1\text{-}20 \text{ w/m}^{\circ}\text{K}$ (see col. 8 lines 44-67).

With respect to Claims 12 and 17, Schoenstein discloses the thermal interface material 23 that is a silicone gel which has a thickness between the semiconductor die and the heat spreader approximately $.5 \text{ mm}$ (i.e. $.5 \text{ mm} = .019 \text{ inches}$) (see col. 9 lines 5-10). Since, Schoenstein discloses an approximate thickness of the thermal interface material then the thickness can be less or more than the specified thickness.

Art Unit: 2827

Schoenstein does not explicitly disclose a thermal interface material with a thickness range of .001 - .010 inches. However, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the thickness of the thermal interface material of Schoenstein to comprise the thermal interface material having a thickness of .010 inches, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or workable ranges involves only routine skill in the art. In re Allen, 105 USPQ.

With respect to Claim 13, Schoenstein discloses assembling a semiconductor die 14 and a heat spreader 16 with a thermally conductive gel 23 (i.e. silicon gel) there between. The gel 23 is cured to form a thermal interface material which has a modulus of elasticity less than 100 psi (i.e. 50 psi = 344.74kPa) (see col. 3 lines 44-51 and col. 5 lines 23-30).

With respect to Claims 14 and 15, Schoenstein discloses the gel 23 that is a polymer (i.e. silicone gel) cross linked polymer gel (i.e. silicone gel) filled with ceramic (i.e. aluminum oxide) which, after the curing is cross linked (see col. 5 lines 23-45, col. 6 line 12-23 and 54-65, and col. 8 lines 44-50). The silicone gel is cross-linked after cured by using an UV light or high-energy radiation. Schoenstein does not explicitly disclose that the polymer gel is lightly cross-linked. However, the examiner interprets lightly cross linked as a gel that is mixed with several materials where one of the material parts per weight is lightly introduced into the final composition of the gel.

With respect to Claim 18, Schoenstein discloses a modulus of elasticity of cured gel (i.e. silicone gel) is less 100 psi (i.e. 50 psi = 344.74kPa) (see col. 3 lines 44-51 and col. 5 lines 23-30).

With respect to Claim 20, Chen discloses a substrate 10 (i.e. a chip carrier for supporting a chip) on which the semiconductor die 20 and heat spreader 50 are mounted (see Fig. 3).

With respect to Claim 21, Chen teaches a substrate 10, wherein the semiconductor die 20 is a flip chip mounted (i.e. chip covered with conductive bump on its face that forms a face down solder connection or controlled collapse chip connection (C4)) on the substrate 10 (see Figs. 1-3).

With respect to Claims 24 and 26, Schoenstein discloses transferring heat from a semiconductor die 14 in a semiconductor die package 10 to a heat spreader 16 in the package with a thermal interface material 23 between the semiconductor die 14 and the heat spreader 16 (see col. 3 lines 1-25; Figs. 1a and 1b). The thermal interface material 23 is a gel (i.e. silicone gel) which has a modulus of elasticity that is less 100 psi (i.e. 50 psi = 344.74kPa) (see col. 3 lines 44-51 and col. 5 lines 23-30).

With respect to Claim 23, Chen discloses a semiconductor die 20 that is memory die (i.e. memory chip). Chen fails to explicitly disclose a semiconductor die that is a central processing unit (CPU). However, one skilled in the art would readily recognize substituting a CPU chip (i.e. CPU die) for a memory chip as evidence by Seyyed (see col. 3 lines 13-18 and col. 4 lines 42 and 43).

With respect to Claim 27, Chen discloses semiconductor die package 100 is an electronic package and the semiconductor die 20 is a flip chip that is a memory die (i.e. memory chip). Chen fails to explicitly disclose a semiconductor die that is a central processing unit (CPU). However, one skilled in the art would readily recognize substituting a CPU chip (i.e. CPU die) for a memory chip as evidence by Seyyedy (see col. 3 lines 13-18 and col. 4 lines 42 and 43).

13. Claim 22 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. (U.S. 6,403,882) Schoenstein et al. (U.S. 6,162,663) as applied to claim 13 and 21 above, and further in view of Vogel et al. (U.S. 6,317,326).

With respect to Claim 22, Chen-Schoenstein both fail to disclose the heat spreader comprising a lid which is mounted on the substrate during the assembling so as to extend over the flip chip. However, Vogel discloses a heat spreader (i.e. lid made of aluminum which serves a heat spreader by transferring heat away from the die via the conductive adhesive 214) comprising a lid 210 in that is mounted on the substrate 202 during the assembling so as to extend over the flip chip 206 (see col. 3 lines 41-47, col. 4 lines 56-62, and col. 6 lines 34 and 35; Figs. 2A and 2B). Chen-Schoenstein and Vogel have substantially the same environment of a chip mounted on a substrate with a heat spreader (i.e. lid), wherein the back surface of the die is bonded to a heat spreader by thermally conductive silicone adhesive. Therefore, it would have been obvious to incorporate the heat spreader comprising the lid connected to a heat sink with the product of Chen-Schoenstein, since the heat spreader including the lid would increase

Art Unit: 2827

heat dissipation from the die while enclosing the die from environment contamination as taught by Vogel.

Allowable Subject Matter

14. Claims 28 and 29 allowed.

15. Claims 7, 19, and 25 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, second paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter: the prior art of record does not teach the combination of a post end-of-line and post reliability testing thermal resistance of the thermal interface material between the semiconductor die and the heat spreader is less than $1 \text{ cm}^2 \text{ } ^\circ \text{C/Watt}$ when the modulus of elasticity of the thermal interface material is in the range of 1-500kPa.

The prior art made of record and not relied upon is cited primarily to show the product of the instant invention.


Conclusion

16. Any inquiry concerning the communication or earlier communications from the examiner should be directed to Alonzo Chambliss whose telephone number is (703) 306-9143. The fax phone number for this Group is (703) 308-7722 or 7724.

Art Unit: 2827

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-7956.

AC/August 24, 2002


Alonzo Chambliss
Examiner
Art Unit 2827